

## Brake disk

The present invention relates to a brake disk according to the preamble of claim 1.

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Such a divided brake disk is sold, for example, by Beringer as AERONAL brake disk. The known brake disk has a steel brake band which is connected to an inner aluminum part via six connecting elements. The brake  
10 band has six extensions which border corresponding extensions of the inner part. The extensions bordering one another have in each case semi-circular recesses which receive the connecting elements. The opposite  
15 edges of the extensions run in the circumferential direction. Those sections of the edges which are in each case before the recess during forward travel in the direction of rotation are arranged a smaller distance away from the center of the brake disk than the corresponding rear sections. The connecting lines  
20 of the ends of the respective semicircular recesses for the connecting elements are therefore inclined about  $12^\circ$  relative to the tangential direction. In a brake disk in new condition, the main load occurring during braking and due to the connecting bolts is no longer in  
25 a region in which the inner part borders the brake band but somewhat further in the centre. Since the extension of the inner part between the edge opposite the extension of the brake band and the inner ring for fixing to a hub is not in the direction of the force  
30 occurring during braking, the higher rear section of the extension bends during braking and the main load is displaced further toward the end of the recesses in the extensions of the inner part. As a result, the recesses are subject to greater wear. Since  
35 furthermore the edges opposite the extension of the brake band run in the circumferential direction, the brake band rotates relative to the inner part in the

circumferential direction with increasing wear and the braking force is furthermore transmitted by the connecting element from the brake band to the inner part. The wear thus increases even further.

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It is therefore the object of the invention to provide a divided brake disk which has little deformation or wear in the region of the connection between the brake band and the inner part in combination with a low weight.

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The object of the invention is achieved by the features of the independent claims. Advantageous developments of the invention are described in the dependent claims.

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According to one embodiment of the invention, a brake disk according to the invention for a disk brake, in particular for motor cycles or bicycles, comprises a brake band of a first material which has a high heat resistance, an inner part of a second material which has a lower density than the first material, the brake band having a plurality of extensions and the inner part having a plurality of extensions, which in each case are arranged in pairs bordering one another, and a plurality of connecting elements which connect the brake band to the inner part by being received in recesses formed in the extensions, the recess being formed in such a way that the connecting line between the ends of the recess is at an angle of from 15 to 85° to the tangential direction.

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In this Application, tangential direction is to be understood as meaning the direction of a tangent of a circle concentric with the brake disk at a point which lies in the region of the recess or of the edge section to which reference is made.

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During braking, brake linings act on the brake band and retard its rotation. The braking force is transmitted from the brake band via the connecting elements to the inner part, which connecting elements are received in the recesses of the extensions. The embodiment according to the invention has the advantage that, during braking, the connecting elements no longer exert a load on the recesses mainly at the ends thereof but further toward the centre of the recesses. Because the load is not applied in the end region, the result is less wear.

The angle is preferably from 20 to 60° and particularly preferably from 25 to 40°. Embodiments having an angle of about 30° are most preferred. It has been found that, at this angle, the loads are best absorbed and the wear is lowest.

That end of the recess which is at the front in the direction of rotation during forward travel is a smaller distance away from the center of the brake disk than that end of the recess which is at the back in the direction of rotation during forward travel.

Alternatively or additionally, those sections of the edges of the extensions which are before the recesses in the direction of rotation during forward travel may be at an angle relative to the respective tangential direction, those respective ends of the regions which are at the front in the direction of rotation during forward travel being a smaller distance away from the center of the brake disk than those corresponding ends of the regions which are at the back in the direction of rotation during forward travel. This has the advantage that the edges of the extensions of the brake band can be supported on the opposite edges of the extensions of the inner part if the recesses in the

extensions of the inner part and/or the connecting elements are worn to such an extent that the edges touch one another as a result of a slight rotation between brake band and inner part in the circumferential direction. Consequently, further pronounced wear is prevented because the braking force can also be transmitted by the abutting edges.

Alternatively or additionally, those sections of the edges of the extensions which are behind the recesses in the direction of rotation during forward travel may be at an angle relative to the respective tangential direction, those respective ends of the regions which are at the front in the direction of rotation during forward travel being a smaller distance away from the center of the brake disk than those corresponding ends of the regions which are at the back in the direction of rotation during forward travel. This results in the advantages mentioned above in relation to the oblique position of sections in front of the recess. Advantageously, both the sections in front of the recesses and those behind the recesses of both the brake band and the inner part are formed in this manner.

The various angles may be of the same size or of different sizes. The edges opposite one another may be linear or at least partly or completely curvilinear.

Alternatively or additionally, the recess or the recesses in the extensions of the inner part can enclose the connecting elements received in them in an angular range of more than  $180^\circ$ . This results in better support in the generally softer inner part and hence less wear, with the further advantages mentioned. Preferably, the recess or the recesses in the extensions of the inner part encloses or enclose the

connecting elements received in them in an angular range of more than 181°, 185°, 190° or 195°. Good results with respect to little wear can be achieved with an angular range of approximately 200°.

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The angular range may be from 185 to 300°, preferably from 190 to 270° and in particular approximately 200°.

The connecting elements may be bolts and/or rivets.

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The brake band may be formed from steel. The brake band may be corrugated or annular. Furthermore, the brake band may have holes which are preferably in the form of slots or circular. For weight reasons, the inner part is preferably formed from light metal or a light metal alloy, in particular from aluminum, an aluminum alloy, titanium, a titanium alloy, a magnesium alloy or another suitable light metal alloy. The inner part may have an inner ring for fixing to a hub.

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The extensions can preferably each have a strut which is at the front in the direction of rotation during forward travel and may each have a strut which is at the back in the direction of rotation during forward travel.

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According to a preferred embodiment, the rear strut is oriented in such a way that the rear strut is substantially in the direction of the braking force occurring during braking in the case of forward travel. This has the advantage that the strut can be made lighter because the loads are lower transversely to the longitudinal direction. This feature may also be advantageous alone without the abovementioned features for divided brake disks and can justify an invention.

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The invention is described in more detail with

reference to the working examples shown in the figures.

Figure 1 shows a side view of a first embodiment of a brake disk according to the invention.

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Figure 2 shows a side view of a second embodiment of a brake disk according to the invention.

Figure 3 shows an enlarged partial view of the side view of the brake disk of figure 2.

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Figure 4 shows a section through a segment of the brake disk, through the region of the connection between brake band and inner part, along the line IV-IV of figure 3.

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Figure 5 shows a schematic diagram of the opposite edges and of the recesses of the extensions of the brake band and the inner part according to the embodiments of figure 1 and figure 2.

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Figures 6-10 show a schematic diagram of alternative developments of the edges and recesses, corresponding to figure 5.

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Figure 11 shows a side view of one of the preferred embodiments of a brake disk according to the invention.

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Figure 12 shows an enlarged partial view of the side view of the brake disk of figure 11.

Figures 13 and 14 show views corresponding to figures 11 and 12, without showing the connecting elements.

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Figure 1 shows a side view of a brake disk according to the invention. The brake disk has a brake band 10 and an inner part 20. Six extensions 11 which are opposite six extensions 21 of the inner part 20 are formed on the brake band 10. The brake band 10 is connected to the inner part 20 by six connecting elements 30 in the regions of the extensions.

The extensions 21 have a strut 211 which is at the front in the direction of rotation 40 for forward travel and a strut 212 which is at the back in the direction of rotation 40 in the case of forward travel. The rear strut 212 is located substantially exactly in the direction of the braking force which is absorbed by the strut and is transmitted from the brake band via the connecting elements 30 to the inner part 20, said direction occurring during braking.

The brake band has an inner ring 25 having six holes 24 for fixing to a hub which is not shown.

The brake band 10 is corrugated and has slots 14 for saving weight and for cooling.

Figure 2 shows an alternative embodiment of a brake disk according to the invention from the side. This embodiment differs from the embodiment shown in figure 1 only in the design of the brake band. The same reference numerals are used. Because of the corresponding components and features, reference will be made to the description of figure 1. Below, the differences will be discussed.

The brake band has an annular shape. Holes 14 are provided in the brake band.

It is clear that, alternatively to the embodiments

shown in figures 1 and 2, brake bands without holes can also be provided.

Figure 3 shows an enlarged partial view of the side view of the brake disk according to the invention of figure 2. The brake band 10 has six extensions 11 which border corresponding extensions 21 of the inner part 20. The extensions 11 and 21 are connected to one another by a connecting element 30, which is shown in section in figure 4. For weight reasons, the extension 21 is formed with a recess which is enclosed by the struts 211, 212 and the inner ring 25.

Figure 4 shows a sectional view through the brake disk of figure 2 along the line IV-IV in figure 3. The connecting element 30 comprises a bolt 31 which has a flange 32 on one side and a groove 34 on the other side. The flange 32 secures the connection between the brake band 10 and the inner part 20 by preventing lateral displacement. A ring 33 which is secured by a circlip 35 which is arranged in the groove 34 is provided on the other side of the connecting element 30.

In an alternative embodiment of the divided brake disk according to the invention, the connecting elements are rivets which have, on both sides, flanges or heads which limit a movement between brake band and inner part in the axial direction. As in the embodiment shown in figures 2 to 4 or in figure 1, the force during braking is transmitted from the brake band to the inner part via the connecting elements. Otherwise, reference is made to the description of the other working examples.

Figure 5 shows a schematic diagram of the formation of the edges 12, 22 and recesses 13, 23 in the transition



region between the brake band 10 and the inner part 20 of the embodiment of the invention which is shown in figure 2. In the diagram, only the edge 12 of the brake band 10 and the edge 22 opposite it are shown for the example of one of the six extensions 11, 21 opposite one another. For the sake of clarity, the connecting element 30 is omitted. The edge 12 of the extension 11 of the brake band 10 has a section 121 which is at the front in the direction of rotation 40 during forward travel and adjacent to which is a recess 13 for receiving the connecting element and a section 122 which is at the back in the direction of rotation 40 during forward travel. The edge 22 of the extension 21 of the inner part 20 accordingly has a section 221 which is at the front in the direction of rotation 40 during forward travel and a section 222 which is at the back in the direction of rotation 40 during forward travel. The recesses 13 and 23 together form an approximately circular passage for receiving the connecting element (bolt or rivet), which is not shown.

Figures 6 to 10 show, by way of example, alternative developments of the edges and recesses 12, 13 and 22 and 23.

For the sake of clarity, figures 6 to 10 omit the reference numerals for the edges and recesses, which, apart from the orientation and size, correspond to the edges and recesses shown in figure 5.

Guide lines which comprise the tangential direction 50, the connecting line 51 between the ends of the recess 13 or the recess 23, the direction 52 of the section 121 or 221 which is at the front in the direction of travel during forward travel, and the direction 53 of the section 122 or 222 which is at the back in the direction of travel 40 during forward travel.

In figures 5 to 10, the angle  $\alpha$  between the tangential direction 50 and the connecting line 51, the angle  $\beta$  between the tangential direction 50 and the direction 52 and the angle  $\gamma$  between the tangential direction and the direction 53 are furthermore shown.

In figure 5, the connecting line 51 corresponds to the directions 52 and 53. The angles  $\alpha$ ,  $\beta$  and  $\gamma$  are of the same magnitude.

In the embodiment of figure 6, the connecting line 51 corresponds to the direction 52 and the angle  $\alpha$  corresponds to the angle  $\beta$ . The angle  $\gamma$  between the tangential direction 50 and the direction 53 is greater than the angles  $\alpha$  and  $\beta$ .

In the embodiment of figure 7, the angle  $\alpha$  between the connecting line 51 and the tangential direction 50 is greater than the approximately equal angles  $\beta$  and  $\gamma$  between the direction 52 and the tangential direction 50 and between the direction 53 and the tangential direction 50, respectively.

In figure 8, the angles  $\alpha$  and  $\gamma$  correspond to one another and are greater than the angle  $\beta$ .

In figure 9, the range of wrap of the recess 23 is greater than the range of wrap of the recess 13. The angle  $\alpha$  between the connecting line 51 and the tangential direction 50 is greater than the angles  $\beta$  and  $\gamma$ , which are of approximately equal magnitude.

In the embodiment of figure 10, the range of wrap of

the recess 23 is likewise greater than the range of wrap of the recess 13. The angle  $\gamma$  between the direction 53 and the tangential direction 50 is greater than the angle  $\alpha$  between the connecting line 51 and the tangential direction 50, which in turn is greater than the angle  $\beta$  between the direction 52 and the tangential direction 50.

Figures 11 to 14 show the currently preferred embodiment of the invention. The brake disk shown corresponds to the embodiment of fig. 2, except for the formation of the extensions 11 of the brake band 10 and of the extensions 21 of the inner part 20. Below, only the differences relative to the embodiment of fig. 2 will be described and otherwise reference will be made to the above description of the embodiment of fig. 2.

Fig. 11 shows a side view of the brake disk with the connecting elements 30. The direction of rotation for forward travel is designated by the arrow 41 on the inner part 20 of the brake disk. Fig. 12 shows an enlarged partial view which shows a cut-out of the brake disk in the region of a pair of extensions 11 and 21 bordering one another.

Figures 13 and 14 show views corresponding to figures 11 and 12, the connecting elements having been omitted for better presentation of the edges of the extensions. The edge 12 of the extension 11 of the brake band 10 has a section 121 which is at the front in the direction of rotation (arrow 41) during forward travel and adjacent to which is a recess 13 for receiving the connecting element, and a section 122 which is at the back in the direction of rotation (arrow 41) during forward travel. The edge 22 of the extension 21 of the inner part 20 accordingly has a section 221 which is at the front in the direction of rotation (arrow 41)

- during forward travel, a recess 23 and a section 222 which is at the back in the direction of rotation (arrow 41) during forward travel. The recesses 13 and 23 together form an approximately circular passage for receiving the connecting element 30 shown in figures 11 and 12. The angular range with which the recess 23 of the inner part 20 encloses the connecting element 30 is approximately 200°.
- 10 Relative to the tangential direction, the front sections 222 of the edges 22 are steeper than the rear sections 221 of the edges 22. Relative to the tangential direction, the connecting line between the ends of the recess 23 is less steep than the front sections 222 of the edges 22 and steeper than the rear sections 221 of the edges 22. The embodiment corresponds substantially to the alternative shown in fig. 10, the angular range of the recesses 23 being somewhat smaller in the embodiment of figures 11 to 14 than in the embodiment of fig. 10, and the front sections 222 in the embodiment of figures 11 to 14 being somewhat less steep than in the embodiment of fig. 10, relative to the tangential direction.
- 25 Further alternatives are conceivable. In particular, the angles  $\alpha$ ,  $\beta$ ,  $\gamma$  shown may vary and the sections 121, 122, 221, 222 may be not only straight but also at least partially or completely curvilinear, for example curved.